09/830908

PCT/AU99/00922

7 / Priority Doc.
E. Willis
10-17-01

06 JAN 2000
PCT

4

AU 99/922

Patent Office
Canberra

I, KAY WARD, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP 6738 for a patent by BAINS HARDING LIMITED filed on 26 October 1998.

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

COMMONWEALTH OF AUSTRALIA
AUSTRALIA
PATENT OFFICE

WITNESS my hand this
Twenty-third day of December 1999

K Ward

KAY WARD
TEAM LEADER EXAMINATION
SUPPORT AND SALES

P/00/009 28/5/91
Regulation 3.2

AUSTRALIA

Patents Act 1990

ORIGINAL

PROVISIONAL SPECIFICATION

INSULATION MODULE, SYSTEM AND METHOD FOR INSTASLLATION AND MANUFACTURE

The invention is described in th following statem nt:

INSULATION MODULE, SYSTEM AND METHOD FOR INSTALLATION AND MANUFACTURE

This invention relates to an insulation module; a system of modules for insulating a component; a method of installation of the insulation modules; and a method of manufacture of the insulation module.

The purpose of insulation is well known, it is to reduce the impact of ambient environmental conditions on desired temperature within the insulated environment by reducing the heat transfer driving force between the insulated and ambient environments. The insulation operation involves the location and fastening of layer(s) of insulating materials, which may be of the same or different nature, about the component to be insulated. The installation may involve wrapping of an insulating material about the component but other constructions, for example panel constructions, which are adhered or otherwise secured to the component may also be employed.

In the industrial context, the objectives of insulation of a component include maintaining a desired temperature within that component; and personnel protection. Thus in a chemical plant, tanks and pipes may hold or carry materials such as solids, gases or liquids which must be maintained within controlled temperature limits for efficient use within the process being conducted within the chemical plant.

Achievement of this objective is directly linked to the cost efficiency of the chemical plant as heating and cooling costs may be substantial and may be reduced by effective insulation to prevent heat loss or gain from the insulated component.

Insulation of a chemical plant is an expensive process. Generally, it has involved the installer in the transport of the necessary cladding and insulation materials to the site where it is then manufactured into the desired form to complete the insulation job. Therefore, the process is time consuming and requires a great deal of organisation to be competently and cost effectively carried out.

Further, there are some insulation materials which, though highly suitable for the purpose of insulation, are nevertheless considered to pose such a risk to

the workers on a site that all non-insulation work must cease while the insulation is installed. This may necessitate working in night environments where the costs of lighting and incidental costs of employment are commensurately higher than during the day.

Typical of such insulation materials for "hot" or non-cryogenic insulation are fibres, particularly man-made materials such as synthetic or natural mineral fibres. One such fibre typically used in chemical plants is fibreglass. The work restraints described above are very pertinent to this fibrous material. For cryogenic insulation, polymeric foams such as polyurethane foams are suitable insulators.

Still further, the costs and effectiveness of current insulation are questionable. These issues are particularly cogent in the context of cryogenic plants which pose particular challenges in terms of controlling the high thermal and stress profiles across the insulation barrier.

It is the object of the present invention to provide insulation modules, systems and methods for the installation of these which avoid, to the maximum practical extent, the cost and safety disadvantages of current techniques while achieving the insulation objective.

With this object in view, a first aspect of the invention provides a pre-formed insulation module comprising:

an insulation layer formed by an insulating material sealed by a sealing agent, having an inner surface contacting a component to be insulated and an outer surface; and

a cladding layer adhered to the insulation layer at the outer surface thereof.

By pre-formed is meant that the insulation module may be manufactured, as a complete insulating article, prior to transfer to, and installation at, a factory site. The factory site may be very remote to the site where the manufacturing plant is located. Such pre-fabrication of modules, which may be installed directly at the site, saves significant site costs and reduces the cost of the insulation project.

The insulating material is typically a fibrous material. Fibres may be synthetic or natural and man-made mineral fibres are especially contemplated

within the scope of the present invention. Non-fibrous cellular materials such as polyurethane may be used as insulating material. The material may take any suitable rigid or flexible form, for example panels, mattresses or blankets.

The pre-formed module may be made up of any desired number of insulating layer(s) and any desired number of cladding layer(s). The insulating layers must include at least one layer of a fibrous material, but may include further layer(s) of insulating materials of same or different nature. Insulation materials may be blended together. The construction of the pre-formed module will be dependent upon the nature of the insulation job and the cost acceptability of the module.

Preferably, the insulation module is provided with means to connect the module with another such module. Thus, in the case where the component to be insulated is a pipe or pipe fitting, such as an elbow or T-joint, a pre-formed module may cover a portion of the pipe or pipe fitting. That module is connected to another module or series of modules to complete the insulation of the pipe or pipe fitting. Conveniently, the modules in this instance may be semi-cylindrical in geometry though the module may be a fractional cylinder of any desired circumferential extent. It may be found that semi-cylindrical modules are suitable for insulation of pipes to about 20" diameter, above that diameter the modules may be made a lesser fraction of a cylinder in circumference. That is it may be found more convenient to use more than two modules to insulate a length of pipe. It will be understood that the module need not be limited in its application to the insulation of pipes and may not be circular or part circular. Many components such as tanks may be insulated using similar pre-formed modules which need not be at all cylindrical in geometry. The determining factors in selection of the design of the module are as follows: the geometry of the component to be insulated, insulation requirements and cost.

The sealing agent sealing the mineral fibres must be such as to substantially contain the fibres in normal use, that is substantially preventing environmentally unacceptable (as dictated by standards or regulations) escape or detachment of fibres, during normal use. Many sealing agents may be suitable for this application. They may be sprayed or otherwise applied to the

mineral fibre product sourced from the mineral fibre supplier to achieve sealing. Poly vinyl acetate has been found to be a suitable agent which is applied to the mineral fibre product by spraying.

The module may be manufactured in any convenient manner but generally the fibrous insulating material is cut to shape, that is the shape of the component, or part of a component to be insulated, sealed with the sealing agent and then adhered to a cladding material.

The cladding material may be a metal such as stainless steel, coated steel or aluminium; or a polymeric material. Mouldable materials, particularly mouldable polymeric materials, may be suitable.The cladding material could be a composite material. It should be resistant to environmental and plant conditions. Typically, the cladding material would require both temperature and corrosion resistance. A fire proofing material may be suitably used as the cladding layer. Materials available under the trade marks CHARTEK and THERMALAG may be suitable. The cladding layer is adhered to the insulating layer by adhesives or other means. Possibly the sealing agent for sealing the matrix of material may be used as the adhesive agent.

The insulation module may be secured into position by fitting onto the component to be insulated. The fitting should take account of any thermal expansion and contraction of the insulated component. The module may also be provided on the inner surface of the insulating layer with connection means which connect it to the component, or a part of the component to be insulated. Modules can be interference or otherwise fitted together. The connection means may be mechanical or chemical in nature but must be durable taking into account environmental and plant conditions. For example, a chemical connection means such as an adhesive would require to be temperature resistant and resistant to small leakage or small plant concentrations of process materials. The connection means should allow water-tight sealing.

In a further aspect of the invention, the pre-fabricated insulation module is specially designed for cryogenic applications. Cryogenic applications pose particular challenges to conventional insulation because the thermal and stress profile of insulation used for such applications is ~~not well understood~~ extreme. By way of

example, the temperature difference between the interior of the insulated component and the ambient environment may be of the order of 200°C such that expansion behaviour may be encountered in outer portions of the insulation and contraction behaviour may be encountered in inner portions of the insulation. The insulation module of the present invention may be designed for the cryogenic application.

In this aspect of the present invention, there is provided a pre-formed insulation module comprising a plurality of insulation layers formed by an insulating material, at least one insulation layer forming a water vapour barrier, an inner insulation layer contacting a component to be insulated and an outer insulation layer having an outer surface; and a cladding layer being adhered to the outer insulation layer at the outer surface thereof.

In this embodiment, the nature of the insulation material, advantageously a polymeric foam such as polyurethane foam, is not fibre containing and use of a sealing agent to seal fibres into the insulating matrix is not applicable in this context.

Each insulation layer of the plurality of layers of insulation is of appropriate thickness and nature to achieve the desired insulation. Five or more insulation layers may be provided, three or more of which may be formed of a polymeric foam. One or more of the insulation layers may form a water vapour barrier. Water vapour barrier layers may be disposed between insulation layers of polymeric foam. A water vapour barrier may typically constitute one of the outer layers of the insulation, at least one being disposed between the cladding and a polymeric foam insulation layer. Alternatively, a polymeric vapour barrier or suitable cladding having low water vapour transmission rate ("WVTR") may be employed.

Water vapour may be reinforced with glass fibres or by other means.

Each of the plurality of insulation layers is bonded to adjacent insulation layers by suitable technique. Advantageously, adjacent insulation layers may be adhered to each other by a suitable adhesive. Mastics of various kinds may be suitable. As mastics are available at various temperature ratings, the mastic employed should be suitably selected for temperature. Thus different mastics

may be required, one mastic being used to adhere outer insulation layers and another mastic being employed for adhering inner insulation layers.

The adhesion operation is one that must be conducted carefully as uniform application of adhesive is necessary across the contacting surfaces of the adjoining insulation layers if appropriate insulation behaviour and avoidance of water vapour ingress is to be achieved. Meeting this requirement may necessitate manual application of the adhesive.

The insulation layers must be fabricated having regard to stress profile, ~~as best it can be understood~~. Thermally induced stresses will exist in both the longitudinal and radial directions of the insulation module and effective insulation must accommodate this.

Each insulation layer will be fabricated, for pipes, in a cylindrical shape. The cylinder will then be cut, typically in a semi-cylinder for fabrication of the module. However, the design is not limited to semi-cylindrical segments. The joints between each semi-cylinder forming each insulation layer are staggered relative to each other. Longitudinal and circumferential joints are provided. The joints are adhered together using mastic or other suitable adhesive. The joints may be of tongue/groove type though dove-tail or furniture jointing may be preferable as tongue/groove arrangements are not easy to use in this application. The water vapour barrier layers may be arranged to overlap the longitudinal and circumferential joints.

Adjoining insulation modules are designed to achieve easy connection to one another. Therefore, the insulation layers may be fabricated to achieve easier adhesion to the adjoining insulation layers of a complementary adjoining insulation module. Thus, the ends of adjoining insulation layers of one insulation module may be arranged in stepwise manner creating suitable areas for application of adhesive and contact with adjoining complementary insulation layers allowing a strong bond to be made between them. Again, such bonding may be achieved using a suitable adhesive, such as mastic.

The insulation layers may have metallic foils arranged between them as a water vapour barrier. ~~this may improve stress behaviour. Silver foils may be most suitable for this application.~~

In a still further aspect of the invention there is provided an insulation system for insulating a component comprised of pre-formed modules of either aspect of the invention described above, adjacent modules being connected together by connection means to form the insulation system insulating the component.

In a still further aspect of the present invention there is provided a method of insulating a component comprising manufacturing pre-formed modules as above described; securing pre-formed modules to a component, or part of a component, and other modules to enable insulation of that component or part of the component.

Pre-formed modules making up the insulation may be connected to one or more adjacent module(s) and/or to the component or part of the component as above described.

In a still further aspect of the present invention there is provided a method of manufacturing an insulation module comprising forming insulation layers of insulating material; forming a cladding material; assembling the cladding and insulation layers together; and forming the assembly into insulation modules for insulating components.

Conveniently, and where necessary, the insulation is sealed in a sealing sealing process accomplished by spraying a sealing agent, for example poly vinyl acetate onto the insulating material for encapsulating fibres. Other sealing agents and methods of application to the insulating material could be employed.

The insulation and cladding materials may be shaped, say into a cylindrical or other suitably shaped pre-form with controlled thickness as required for effective insulation, and adhesive may be sprayed onto the surface of the cladding material to be adhered to the matrix of insulating material. The adhesive agent is then applied to the pre-form of insulating material which is then adhered to the cladding material. It is also possible for the adhesive agent to be applied only to one of the insulating or cladding layers. Other methods of application of adhesive or adhesion, that is fastening or connection, could be used in accordance with the invention.

The module, system and method of installation forming aspects of the

present invention present cost, efficiency and safety advantages over systems and methods currently employed for insulation. Insulation modules are also readily replaceable in the event of service failure.

The various aspects of the invention may be more completely understood from the following description of preferred embodiments thereof made with reference to the accompanying drawings in which:

Figure 1a is a side sectional view of a pre-formed module suitable for insulation of a length of pipe made in accordance with one embodiment of the present invention;

Figure 1b is an exploded view of two pre-formed modules showing the assembly;

Figure 2 is a perspective view of two pre-formed modules fitted together to insulate a portion of a pipe in accordance with a second embodiment of the invention;

Figure 3 is a front sectional view of a system of modules as shown in Figures 1 and 2 insulating a length of pipe;

Figure 4 is a front sectional view of a system of modules insulating a pipe fitting being an elbow;

Figure 5 is an exploded end view of a pre-formed module suitable for insulation of a length of pipe in a cryogenic application;

Figure 6 is a front sectional view of a pre-formed module, the end view of which is shown in Figure 5; and

Figure 7 is a schematic flowchart of the manufacturing operation of an insulation module in accordance with the invention.

Modules

Referring now to Figure 1, there is shown an insulation module 10 in accordance with one embodiment of the invention. The module 10 is of semi-cylindrical shape suitable for use in the partial insulation of a pipe, partial because the insulation module will need to co-operate with further modules to completely insulate the pipe. Modules may be designed which allow insulation by a single module of hinged or analogous construction.

The module 10 has an insulation layer 14 and a cladding layer 18. These

layers are, in the case of a semi-cylindrical module, substantially semi-cylindrical and co-axial. The insulation layer 14 sits within the cladding layer 18 and a neat fit is envisaged though, in the embodiment shown, an adhesive agent is employed to secure assembly of the insulation and cladding layers 14 and 18. A separate and distinct adhesive layer could be formed during manufacture. It will be seen that the cladding layer 18 is formed with greater circumferential extent than the insulation layer 14. The overlapping portions 18a are connection means designed to overlap circumferentially with the cladding layer 28 of another insulation module 20 of substantially similar construction to module 10 except that the insulation and cladding layers 24 and 28 are of substantially similar circumferential extent. Other connection means of mechanical or chemical nature may be employed instead of, or additionally to, the connection means or overlapping portion 18a described.

Thus module 10 is formed with circumferential beads 16 and 17; and module 20 with circumferential beads 26 and 27. The beads may be connected by longitudinally extending beads 126. Beads 16 and 26 are formed at ends 13 and 23 of modules 10 and 20. Beads 16, 17, 26 and 27, shown of V shape but other shapes are not excluded, strengthen the module and may act as water seals, preventing water ingress by capillary action. Beads 17 co-operate and engage with complementary portions of beads 27 to allow at least partial locking together of the modules 10 and 20 as suggested by Figures 1b and 2. These beads may have a further function as described below. In the embodiment shown, the portion 16a of bead 16, formed on overlapping portion 18a of cladding layer 18 of module 10, is generally V shaped presenting on the inner face 18b of overlapping portion 18a a V shaped channel which accommodates the complementary inverted V shaped bead 26 of module 20. Accommodation may involve an interference fit to achieve fastening but other connection means could be adopted. As shown in Figure 3, the connection of modules 10 and 20 may be made more secure by spot welding or riveting. Water sealing agents or tape may also be employed for water-tight sealing.

Modules 10 and 20 are designed such that the cladding semi-cylinders are of greater length than the insulation semi-cylinders. Thus at ends 11 and 21

of the modules 10 and 20 the cladding and insulation cylinders are co-terminous. At the ends 13 and 23, the cladding semi-cylinder extends past the end of the insulation semi-cylinder forming connection portions 19 and 29. These connection portions 19 and 29 are intended to overlap one end of adjacent insulation modules to be fastened thereto, as shown in Figure 3, in the manner typical of connection of pipes in the plumbing art. Beads 16 and 26 assist the fastening, in much the same manner as described above, with complementary beads on adjacent modules. Bead 126 may similarly co-operate with a corresponding longitudinal bead and be made water-tight. Welding or rivetting may be employed, particularly with the circumferential beads 16, 17, 26 and 27, to complete the job by forming a substantially continuous and complete insulation layer along the length of pipe or along the surface of a component to be insulated when the adjacent modules are correctly engaged. Fastening could also be achieved using screws or by strapping of the modules together by metal bands. The fastening is such as to achieve a water-tight seal. Joints may be taped with water-proof tape for this purpose or sealants, such as silicone sealants, may be employed.

Referring to Figures 1 to 3, and considering the modules 10 and 20 that have been described, the overlapped end portion of each module is marked 110 and 120 respectively. The connection portions 19 and 29 are of substantially the same length as the end portions 110 and 120 which are terminated at one end by beads 17 and 27. Connection portions 19 and 29 are intended to be slid over the end portions 110 and 120 of adjacent modules, for example 500 and 600, until prevented from further movement by beads 17 and 27. Thus beads 17 and 27 act as gauges during assembly showing that adjacent modules have been correctly secured together, the final fastening being made by riveting or spot welding or otherwise using water sealing agents and tape as appropriate. At this point, the insulation layers of the adjacent modules 10, 20 and 500 come into contact, secured if desired, forming a substantially continuous and complete insulation layer along the length of the pipe. Gaps are to be avoided.

Modules 10 and 20, as described above, are suitable for insulation of

substantially straight lengths of pipe. The modules may be customised for insulation of pipe fittings as well as other components. Figure 4 shows a series of insulation modules 30, 40, 50, 60, 70 and 80 shaped and cut to suit the radius and degree of a bend or elbow in a pipe to be insulated. Such modules are available from Bains Harding Industries Pty Ltd under the trade-mark INSTA-LAG.

Referring now to Figures 4 and 5, there are shown insulation modules 310 and 320 suitable for use in cryogenic applications. The design of the modules differs as will be explained from that described above for "hot" insulation to accommodate the special challenges inherent in crogenic insulation. Chief of these challenges is the need to accommodate the high thermal stresses induced by a temperature differential of some 200°C to 250°C between interior of insulated component and ambient environment. Each module 310 and 320 has a number of foam insulation layers 314a to 314c and a cladding layer 318. Water vapour barrier layers 351 to 353 are also disposed between cladding layer and foam insulation layer 314a; and between foam insulation layers 314a, 314b and 314b, 314c respectively.

Cladding layer 318 may take the form of a metallic or polymeric material as described in relation to modules 10 and 20. Alternatively, the cladding layer 318 may be fabricated from a fireproofing material such as that available under the registered trade marks CHARTEK, available from Chartek Inc; or THERMALAG, available from Thermal Science Inc. Cladding layer 318 may form a water vapour barrier layer.

Disposed between the cladding 318 and primary foam insulation layer 314a is a primary water vapour barrier 351. This layer must have very low water vapour transmission rate (WVTR) and may be fabricated from a metallic foil such as aluminium foil or a polymeric film or laminate such as that available under the trade mark MYLAR.

Further insulation layers 314a to 314c are fabricated from a polymeric foam such as polyurethane or polyisocyanurate foam. Each layer is substantially cylindrical and co-axial. The thickness of each layer is approximately 50 mm, the exact thickness will be selected in accordance with

appropriate engineering standards ~~such as the Shell DEP~~.

Secondary and tertiary water vapour barrier layers 352 and 353 are disposed between foam insulation layers 314a, 314b; and 314b, 314c respectively. All water vapour barrier layers have the same properties as the primary water vapour barrier layer 351 described above. The water vapour barriers may be reinforced with glass fibres.

Each foam insulation layer 314a to 314c incorporates at least one suitable contraction joint 370 designed and arranged to accommodate expansion/contraction along the portion of pipe insulated with the insulation modules 310 and 320. It will be noted that each contraction joint 370 is staggered in longitudinal and circumferential location relative to another. This arrangement is used to allow secure jointing and minimum risk of water vapour ingress.

Each insulation layer 314a to 314c is bonded to adjoining insulation or water vapour barrier layer(s) by a suitable technique such as adhesion. In the embodiment shown, each layer is bonded to its adjacent layer by mastic adhesive.

Insulation and water vapour barrier layers 314a to 314c, 351, 352 and 353 are adhered together by mastic having temperature rating -29°C to + 21°C and available under the trade mark 60-38 FOSTESS.

As layers disposed inward of secondary water vapour barrier 352, that is 314b, 353 and 314c are subject to colder temperatures, a different mastic or adhesive having temperature rating is used. A suitable adhesive is available under the trade mark 60-96 ADH and has rating -190°C to + 120°C. Failure to use an appropriately rated adhesive may result in cold embrittlement and failure of the insulation module.

Each foam insulation layer 314a to 314c is fabricated with both circumferential joints 341a, 342a, 343a and longitudinal joints 361, 362 and 363 designed to allow suitable secure connection of adjoining modules 310 and 320 as well as other modules not shown. A number of jointing techniques may be used but tongue/groove arrangements are unlikely to be suitable due to the difficult tolerances and fitting involved. Jointing techniques familiar in the

furnituremaking art are advantageously employed.Water vapour barrier layers 351, 352 and 353 are arranged to overlap each of these joints.

Longitudinal joints 361-3 are conveniently shown in Figure 5. At each end of the insulation module 310 and 320, each foam insulation layer 314a to 314c is fabricated with circumferential joints 341a, 342a and 343a as shown more conveniently in Figure 6 to form a stepwise arrangement. Each such circumferential joint or overlap is of sufficient area to allow a good secure bond to be made between complementary adjoining insulation layers of adjoining insulation modules with the appropriately temperature rated adhesive, advantageously a mastic.

In an alternative embodiment, insulation layers 314c and 314d may have disposed between them a thin metallic foil, such as a silver foil, which may assist in the accommodation of thermal stresses.

The modules described with reference to Figures 4 and 5 are available from Bains Harding Industries Pty Ltd under the trade mark CRYO-LAG.

<u>Method of Manufacture</u>

The manufacture of the insulation modules 10, 20, 310 and 320 is shown schematically in Figure 5.

The material forming the insulation layer 14 may be supplied in the form of a hollow cylinder which is cut substantially along a centre line thereof to allow formation of the insulation layer 14. The linear diameter of the cylinder and thus the insulation module 10 is selected to allow an engineered clearance to a pipe to be insulated.

Low cost insulation materials are man-made materials made up of fibres. The fibres may be natural or synthetic, typically mineral, fibres such as fibreglass. It is such materials that have posed safety difficulties in on-site manufacture and installation in the past. Cellular materials may also be employed, for example cellular polyurethane foams. Such materials may take the place of fibrous materials as described.

The cylindrical pre-form of the fibreglass may be sprayed with poly vinyl acetate or other suitable sealing agent to seal the insulating material . Sealing prevents escape of substantial quantities of fibres and unsatisfactory levels of

such fibres in the insulation environment. Spraying could be replaced with alternative methods for applying the sealing agent, say dipping or brush application or other methods of application.

The application may be done before or after other manufacturing steps but typically prior to adhesion of the cladding material as prior application of the cladding layer may prevent proper sealing of the insulation material.

Typically the cladding material is metallic in nature, say of stainless steel, coated steel or aluminium. Polymeric or composite materials could also be used. Fireproofing materials could be used for the cladding as described above. In other words, the cladding material may be as conventionally employed in the insulation art and should be resistant to plant conditions, particularly corrosion and temperature resistance. The cladding material may be painted. The cladding is likewise pre-formed into cylindrical (or other shape) lengths though having greater outer diameter than that of the cylinder of insulating material, it being remembered that overlapping portions 18a must be formed for one of the modules, module 10. Beads may be formed both circumferentially and longitudinally to assist in fastening as above described. The circumferential beads may intersect an axis of a module at any desired angle. The pre-form may then be cut to semi- or part- cylindrical or other suitable shape.

The finished modules 10 and 20 are formed by combination of adhesive and appropriate fitting techniques, for example neat or interference fitting techniques, to secure the insulation material within the cladding. Following setting or curing of the sealing agent to seal the insulation material, the adhesive may be sprayed onto one outer surface 16 of the semi-cylinder of insulation material following which it may be fitted and adhered to the semi-cylinder of cladding material to which adhesive has also been applied on an inner surface of the cladding pre-form. Alternatively, the cladding material only may be sprayed or otherwise provided with a layer of adhesive, the insulation pre-form being pressed into position. Either the cladding or insulation materials or both could have an adhesive layer applied to them to allow adhesion. Any adhesive must be suitable for adhesion of metallic and fibrous materials. The

adhesive must be suitable for durable use in the insulated environment. A solvent based adhesive sourced from Bostik under the trade name Bostik 1831 has been found suitable.

It is not absolutely necessary for adhesives to be used; the cladding and insulation layers 14 and 18 could be secured together by chemical bonding or mechanical techniques. Nevertheless the use of adhesives is recommended for cost efficiency and practical reasons. It is most important that the insulation and cladding layers 14 and 18 of the module 10 do not delaminate during transport to the site or before expiry of their service life.

The insulation module may be formed in lengths or customised to any particular component to be insulated, particularly for particular components such as pipe fittings in a process plant though other applications for the module may be envisaged. A kit of modules could be formed by cutting the lengths to smaller convenient sizes on-site or in the factory. These sub-modules are then available for installation at the plant. It may be understood that lengths and number of modules should be convenient for cost-effective transport to site.

In the case of a bend or elbow, as described in relation to Figure 4, suitably shaped pre-forms of fibreglass and cladding material to accommodate the elbow are obtained and assembled in the same manner of manufacture as modules 10 and 20 with cutting of the modules 30-80 to the requisite shape.

Important differences are involved in the method of manufacture of the cryogenic modules.

Firstly, as the insulation layers of insulation modules 310 and 320 do not contain fibres, it is unnecessary to seal the insulation matrix with a sealing agent. However, as a water vapour barrier is necessary, a material with water vapour barrier characteristics must be incorporated as one of the layers. Two or more such barriers may require to be incorporated. In the embodiment shown, one such barrier 351 is disposed between the cladding 318 and primary foam insulation layer 314a. Further barriers 352 and 353 are disposed between foam insulation layers 314a, 314b; and 314b, 314c respectively.

The multi-layer configuration of the insulation modules and the need for secure bonding between the several layers requires joints to be fabricated in

each foam insulation layer 314a to 314c in a manner known in the furniture making art. These joints must be staggered apart to create a sufficiently secure joint. Each end of the insulation module must also have insulation layers fabricated in a stepwise fashion which allows for more secure bonding. Further, each insulation layer must incorporate a contraction joint of suitable type.

Each adhesive layer must have substantially constant thickness. If a mastic is used and a 4 mm thickness ~~adhesive~~ layer is required, the mastic must be uniformly applied to a depth of about 6 mm. This depth falls to about 4 mm on setting. This is difficult to achieve by automated means and manual application of adhesive may be required. It is not desirable to score the insulation layers as this may create ridges which prevent formation of an adhesive layer of uniform thickness.

The various insulation and water vapour barrier layers 351,314a, 352, 314b, 353 and 314c must also be adhered together using an appropriately selected adhesive such as mastic with an appropriate thermal rating as described above.

<u>Method of Insulation</u>

The installation method for a pipe or pipe fitting proceeds as follows. From design data, the pipe length is determined and insulating modules of the same kind as modules 10 and 20 described above are manufactured to allow insulation of that pipe. For a given length of the pipe, two semi-cylindrical modules are required. A greater number of modules could be used where pipe diameter suggests that modules of lesser circumferential extent than semi-cylindrical are more conveniently to be installed on the pipe. One module 20 is then press fitted onto the pipe. The other module 10 is likewise fitted onto the pipe with overlapping portions 18a of the cladding fitting over the surface of the first module 20 to connect them together on interference fitting of bead 16 within channel 26. Welding or riveting or other fastening is employed to complete the job. This is especially done at the circumferential beads though could also be done along the longitudinal bead. Water-tight sealing is advantageous. This may be achieved with water-proof tape and/or sealants such as silicone sealants.

Use of two modules is unlikely to insulate an entire pipe, other like modules are probably to be employed. In this case, adjacent modules must co-operate and be connected together to properly insulate the pipe. As has been described above, connection portions of modules 10 and 20 are overlapped with the end portions of an adjacent module and with each other suitably securing adjacent modules together to create a water seal particularly when supplemented by use of welding, rivetting and/or use of sealants and a substantially continuous and complete insulation layer along the length of pipe.

This process proceeds until the entire pipe is insulated. The invention is applicable to insulation of plant components other than pipes in which case design data is first sought for the component and pre-formed modules manufactured for the insulation job. The module(s) and systems may be utilised in concert with conventional insulation methods where design features of the plant recommend this.

Again, there are some differences in the assembly method of the cryogenic insulation modules. When connecting adjoining modules, suitable adhesives must be used and care must be taken to use mastic or other adhesive of appropriate thermal rating. Also, all joints must be taped or covered using metallic foils, for example aluminium foils, suitable polymeric films or laminates with very low WVTR to prevent water vapour ingress.

Modifications and variations may be made to the present invention or consideration of the disclosure by the skilled reader of this disclosure. Such modifications and variations are considered to fall within the scope of the present invention.

<u>DATED</u> this 27th day of October, 1998

<u>BAINS HARDING LIMITED</u>

WATERMARK PATENT & TRADEMARK ATTORNEYS
4TH FLOOR, "DURACK CENTRE"
263 ADELAIDE TCE PERTH W.A. 6000 AUSTRALIA

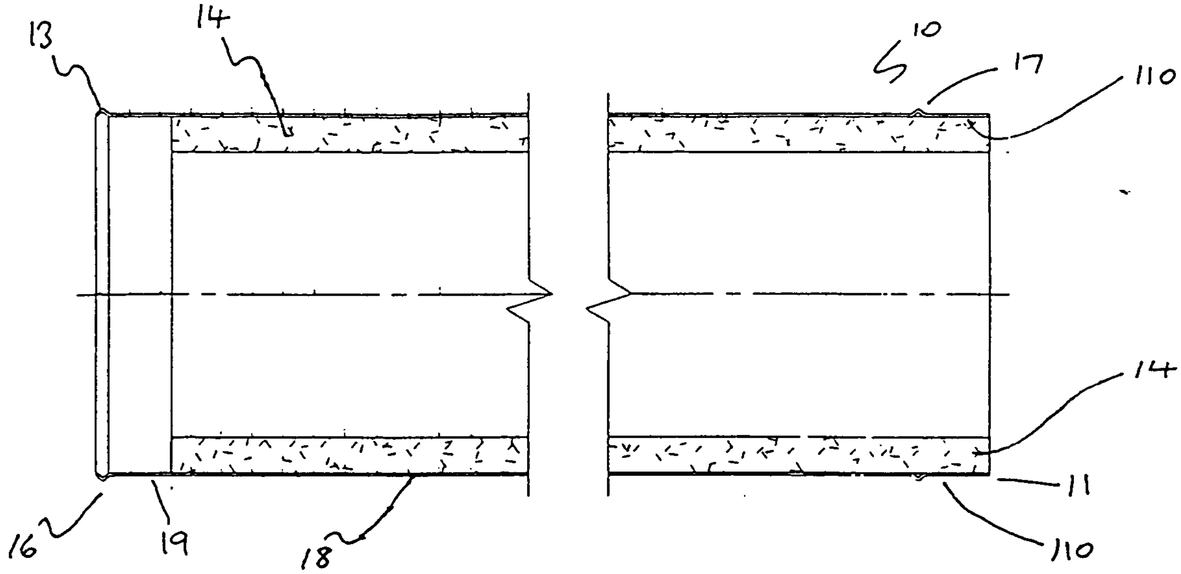


Figure 1a

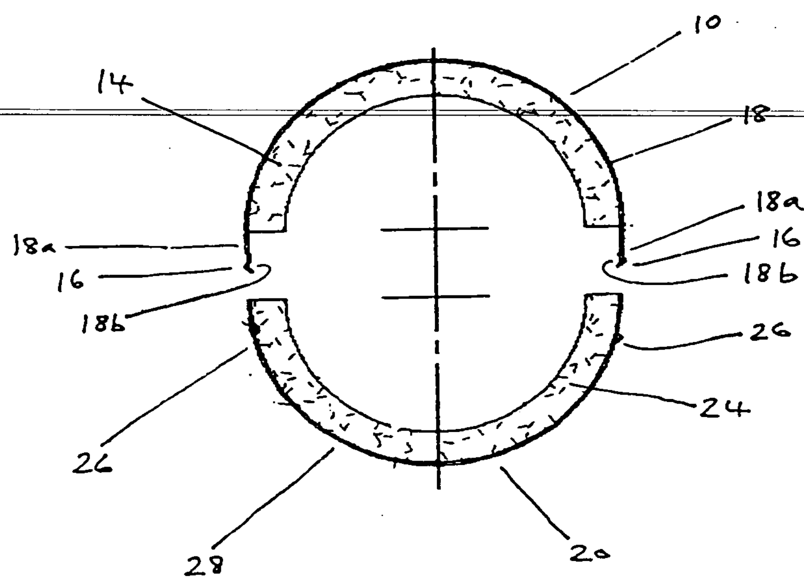


Figure 1b

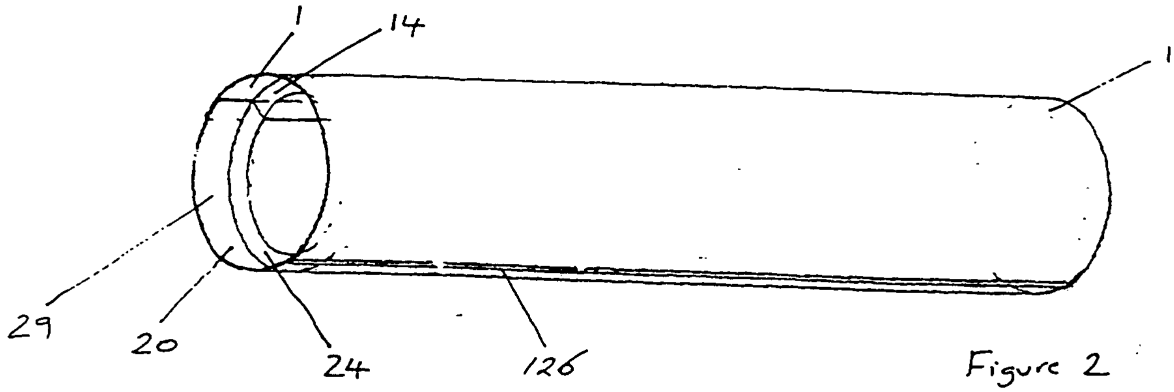


Figure 2

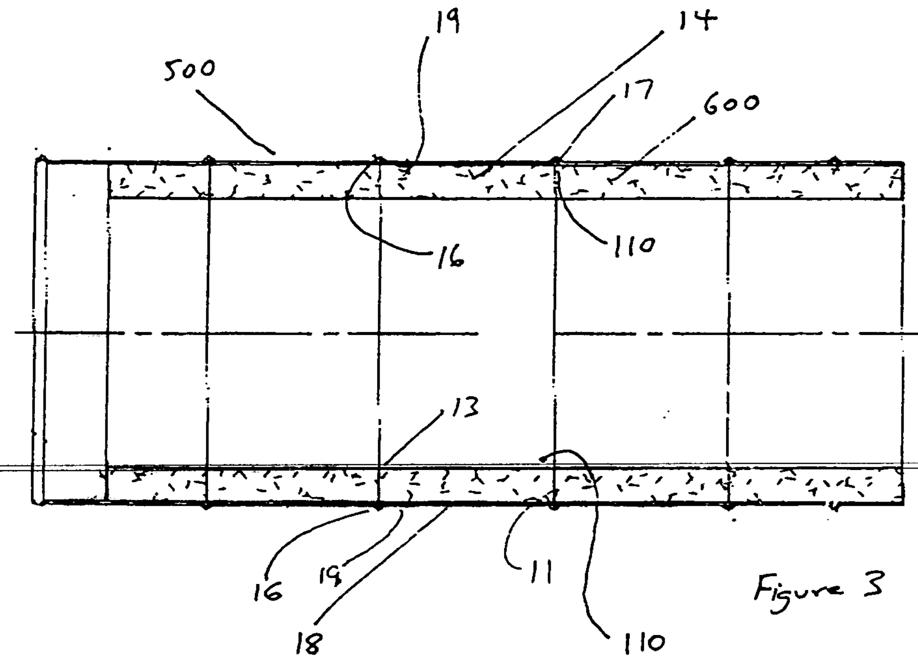


Figure 3

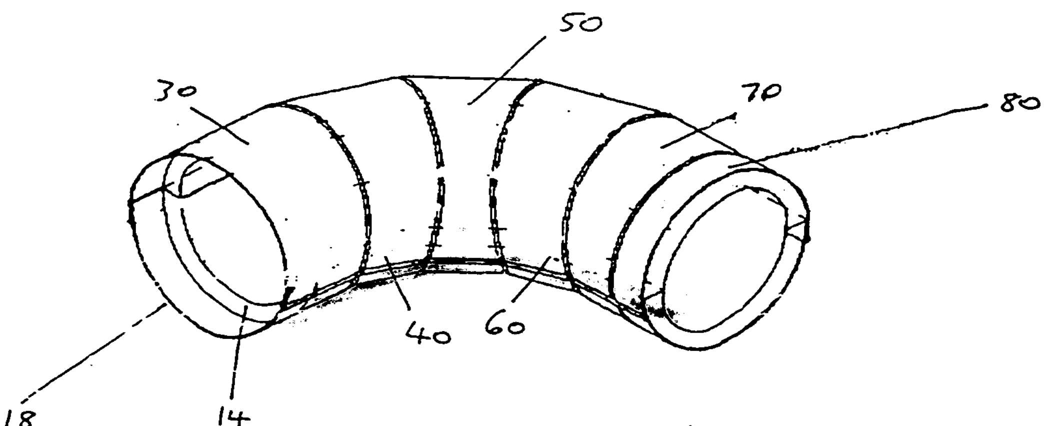


Figure 4

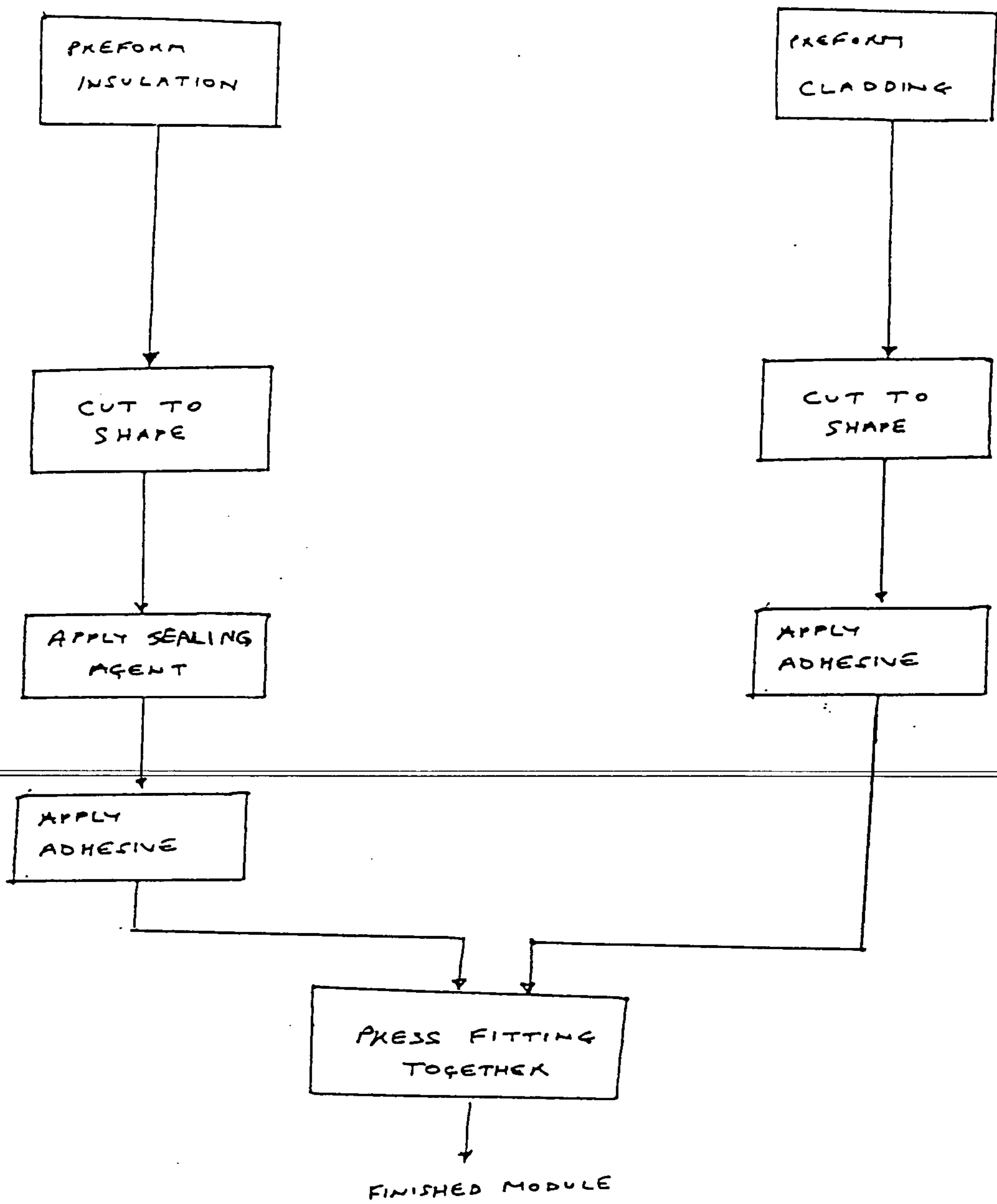

PREFORM INSULATION
PREFORM CLADDING
CUT TO SHAPE
CUT TO SHAPE
APPLY SEALING AGENT
APPLY ADHESIVE
APPLY ADHESIVE
PRESS FITTING TOGETHER
FINISHED MODULE

Figure 5

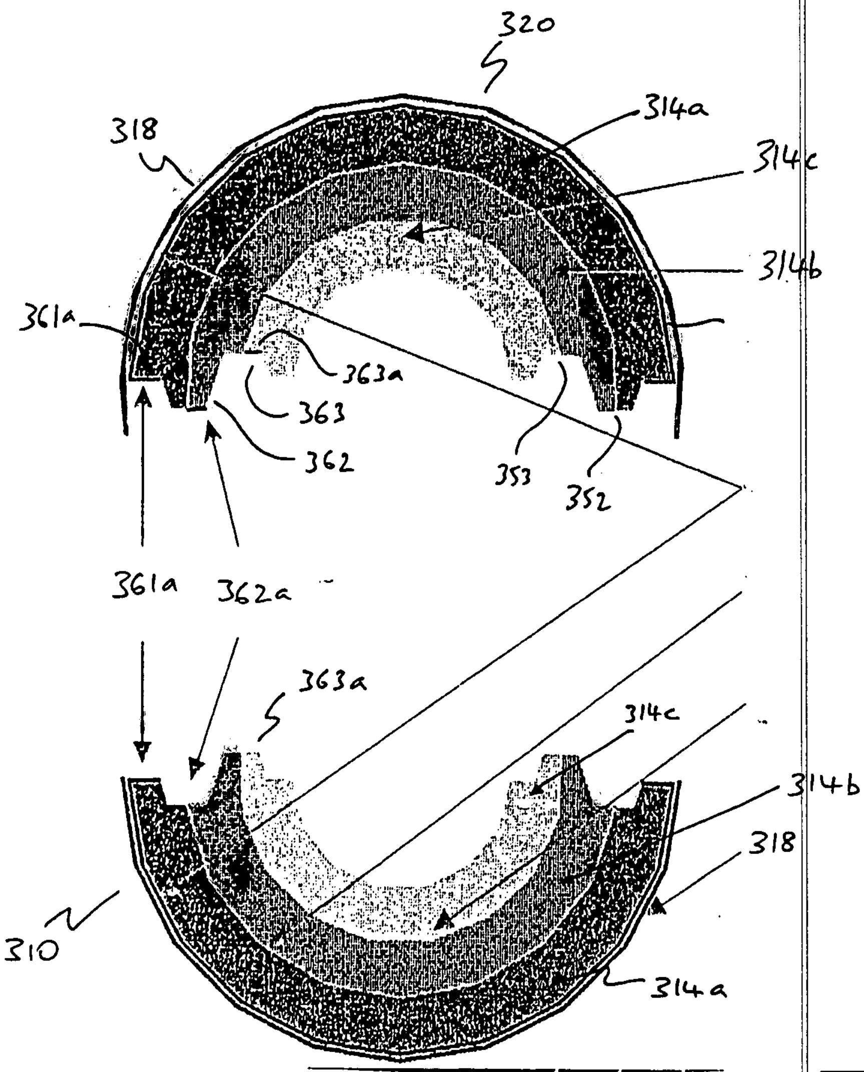
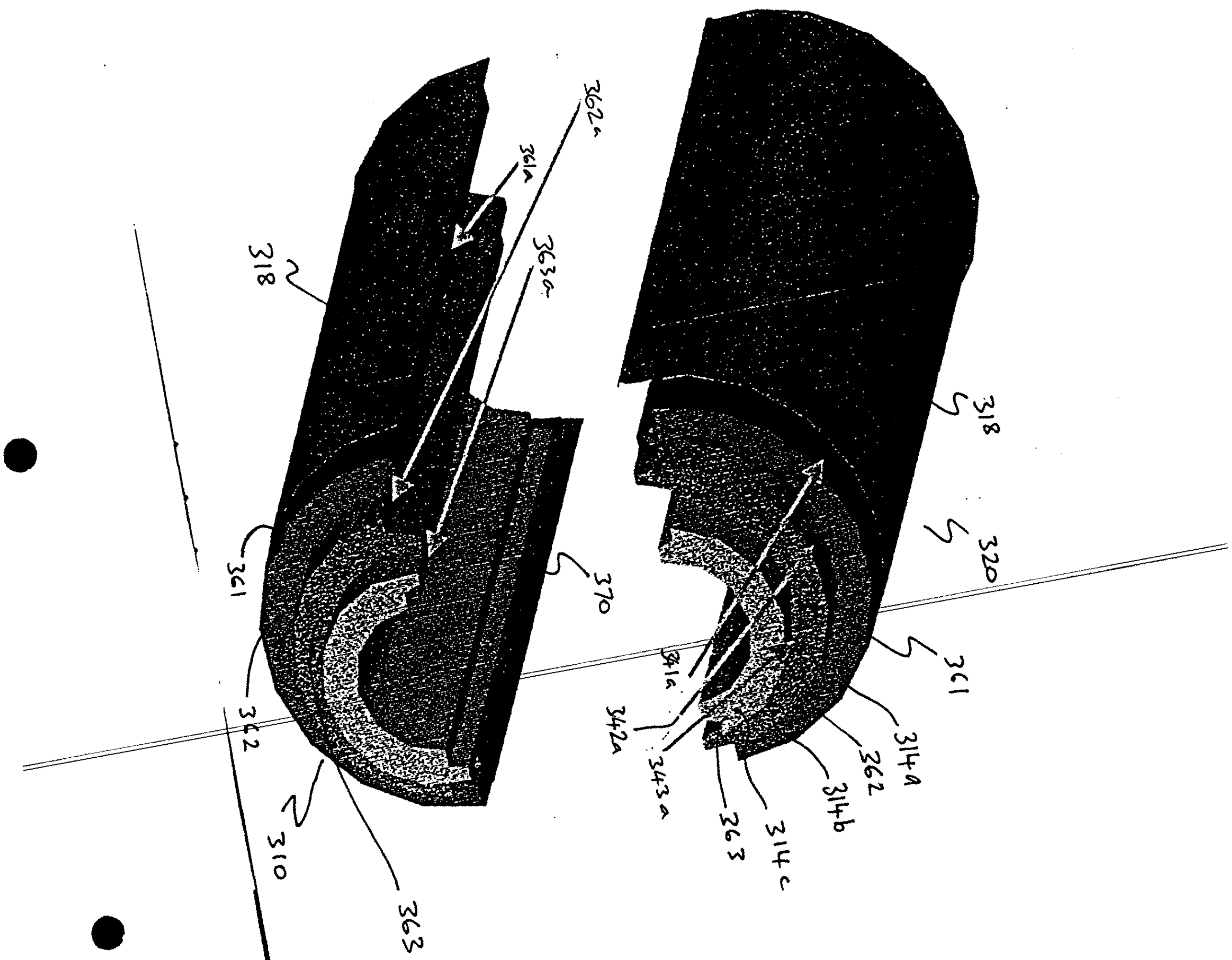

320
318
314a
314c
314b
361a
363a
363
362
353
352
361a
362a
363a
314c
314b
318
310
314a

Figure 5



318
361a
362a
363a
361
370
362
310
363
318
320
361
341a
342a
343a
314a
362
314b
314c
363

Figure 6